New Hampshire Volunteer Lake Assessment Program

2003 Interim Report for Beaver Lake Derry

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Water Division
Watershed Management Bureau
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **BEAVER LAKE, DERRY,** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the lake/pond this season! Your monitoring group sampled **five** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

  The current year data (the top graph) show that the chlorophyll-a concentration ***remained relatively stable*** from May to June, ***increased slightly*** from June to July, ***decreased slightly*** from July to August, and then ***remained relatively stable*** from August to September. The chlorophyll-a concentration on each sampling event was ***less than*** the state mean.

  Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***variable, but overall slightly decreasing*** in-lake chlorophyll-a trend, meaning that the concentration has ***fluctuated, but overall has slightly improved*** since monitoring began in 1990. In the 2004 annual report, we will again conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  The current year data (the top graph) show that the in-lake transparency ***remained relatively stable*** from May to June, ***decreased slightly*** from June to July, ***increased*** from July to August, and then ***remained relatively stable*** from August to September. The transparency in May and June was ***approximately equal to*** the state median, in July was ***slightly less than*** the state median, and in August and September was ***slightly greater than*** the state median.

  The historical data (the bottom graph) show that the 2003 mean transparency is ***slightly greater than*** the state mean.

  Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***relatively stable*** trend (aside from the 1998 data) for in-lake transparency, meaning that the transparency has ***remained***

approximately the same since monitoring began in 1990. As discussed previously, in the 2004 annual report, we will again conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased slightly*** from May to June, ***increased*** from June to July, and then ***decreased consistently*** from July to September. The phosphorus concentration in May and August was ***approximately equal to*** the state median, in June and September was ***slightly less than*** the state median, and in July was ***greater than*** the state median.

  The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***approximately equal to*** the state median.

  The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***decreased slightly*** from May to June, ***increased greatly*** from June to July, ***decreased greatly*** from July to August, and then ***increased*** from August to September. The phosphorus concentration in May and August was

approximately equal to the state median, in June was ***slightly less than*** the state median, and in July and September was ***greater than*** the state median.

The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***greater than*** the state median.

Overall, visual inspection of the historical data trend line for the epilimnion show a ***relatively stable*** phosphorus trend, which means that the concentration has ***remained approximately the same*** since monitoring began.

Overall, visual inspection of the historical data trend line for the hypolimnion shows a ***variable, but overall slightly declining*** phosphorus trend, which means that the concentration has ***fluctuated, but overall has slightly improved*** since monitoring began.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed this year were ***Fragilaria*** **(diatom),** ***Asterionella*** **(diatom),** ***and Anabaena*** **(cyanobacteria).**

  Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria (Blue-green algae)**

  One of the most dominant plankton species observed in this year's sample was the cyanobacterium ***Anabaena.*** In addition, a small amount of the cyanobacterium ***Oscillatoria*** was found in the sample. ***These species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.***

  Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur. During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to nutrient loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of nutrient loading to surface waters.

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spot this season ranged from **6.54** in the hypolimnion to **7.07** in the epilimnion, which means that the water is ***slightly acidic*** in the bottom layer of the lake. When organic matter is decomposed, acids are released into the water column, which may explain the slightly acidic level of the hypolimnion sample.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **16.34 mg/L** which is ***much greater than*** the state mean. The ANC of the lake has been ***much greater than*** the state mean since monitoring began, which means that it has a ***low vulnerability*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

  Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The conductivity has ***increased*** in the lake/pond and inlets since monitoring began. In addition, the in-lake conductivity (225 uMhos/cm) is ***much greater than*** the state mean. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

  We recommend that your monitoring group conduct stream surveys and storm event sampling along the inlet(s) with elevated conductivity so that we can determine what may be causing the increases.

  For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 8: Total Phosphorus**
  Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The total phosphorus concentration was ***elevated*** in **Jenny Dickey Brook** and **Cat-O-Brook** this season. These stations have had a history of ***elevated*** and ***fluctuating*** total phosphorus concentrations. We recommend that your monitoring group conduct stream surveys and storm event sampling along this inlet so that we can determine what may be causing the increases.

  For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***low in the hypolimnion*** at the deep spot of the lake/pond. As stratified lakes/ponds age, and as the summer progresses, oxygen becomes ***depleted*** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to approximately 1 mg/L or less in the hypolimnion **(as it was this season and in all past seasons)**, the phosphorus that is normally bound up in the sediment may be re-released into the water column.

  The ***low*** oxygen level in the hypolimnion is a sign of the lake's/pond's ***aging*** and ***declining*** health. This year the DES biologist conducted the temperature/dissolved oxygen profile in ***September.*** We recommend that the annual biologist visit for the 2004 sampling season be scheduled during ***June*** so that we can determine if oxygen is depleted in the hypolimnion ***earlier*** in the sampling season.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  The turbidity of the hypolimnion (lower layer) sample was elevated on the September sampling event. This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

  The turbidity in **Cat-O-Brook** sample was ***slightly elevated*** on the July sampling event, which suggests that the stream bottom may have been disturbed while sampling, that erosion is occurring in this portion of the watershed, or that runoff from roads (and other non-permeable surfaces) is prevalent.

  When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

  If you suspect that erosion or stormwater runoff is occurring in this portion of the watershed, we recommend that your monitoring group conduct stream surveys and storm event sampling along this inlet. This additional sampling may allow us to determine what is causing the elevated levels of turbidity.

  For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

NOTES

- **Monitor's Note (5/28/03):** Cat-O Brook and Jenny-Dickey Brook had extremely high volume flow. Manta Brook was not flowing.

  (6/25/03): Manta Brook and Jenny-Dickey Brook were flowing rapidly. Cat-O Brook had slow flow.

  (7/22/03): Tributaries had high volume of water but low flow. There has been interference with other lake traffic for the past 10 years. Bouncing of small row boat made it difficult to get a good secchi disk reading with the overcast conditions. Began light rain during tributary sampling.

(8/20/03): All brooks were flowing slowly. Lake water was extremely high for this time of year. Collection conditions the best this year.

(9/10/03): Very low flow in Cat-O Brook. No flow in Manta Brook but ample taken anyway. No flow in Jenny Dickey Brook so no sample taken.

- **Biologist's Note (7/22/03):** The phosphorous at Cat-O Brook and Jenny-Dickey Brook was high.

  (8/20/03): The total phosphorus level at Cat-O Brook was found to be high.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, *NHDES-WD 97-8*, NHDES Booklet, (603) 271-3503.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, *WD-BB-9*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

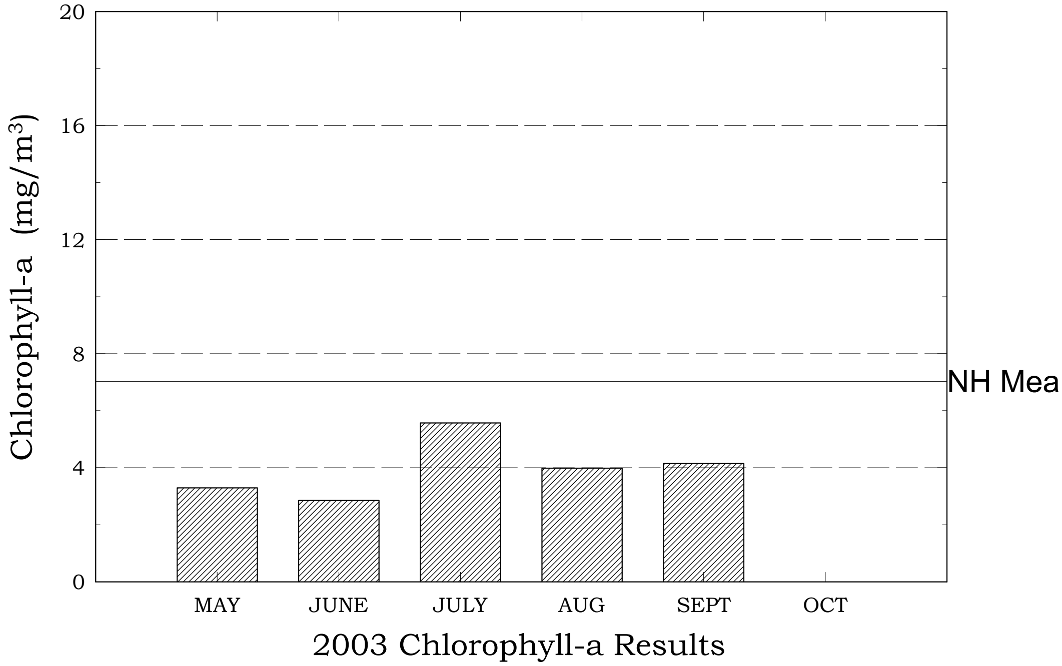
Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

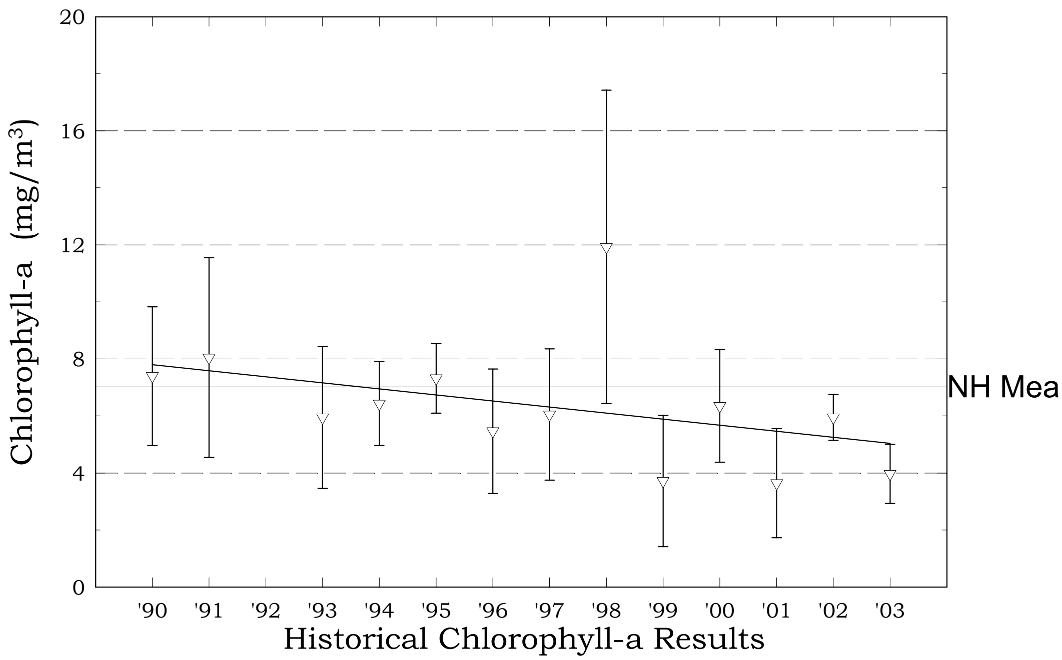
APPENDIX A

GRAPHS

Beaver Lake, Derry

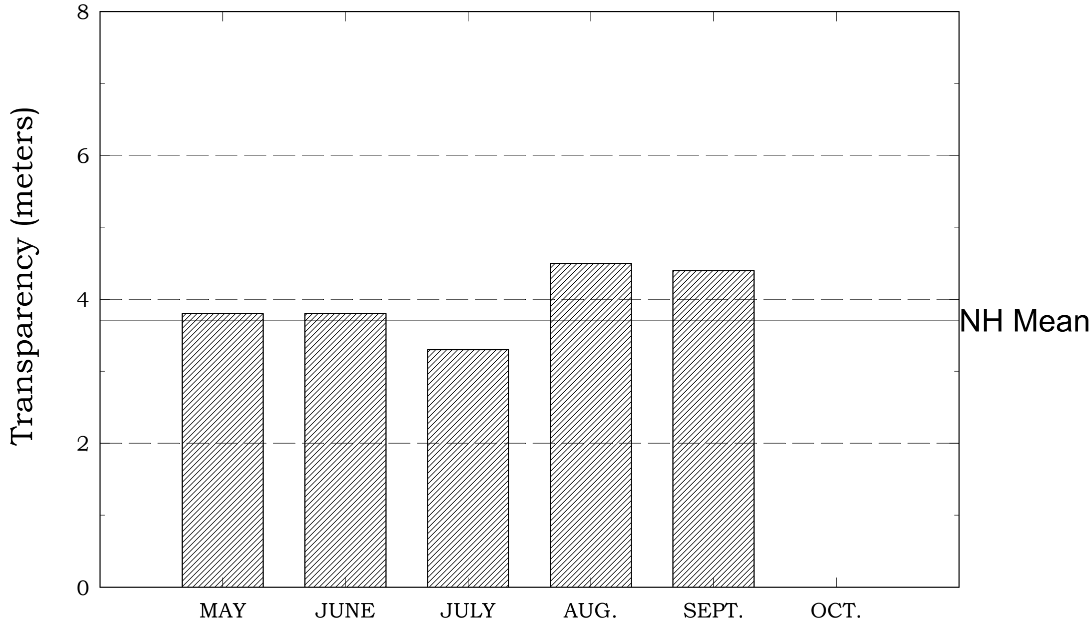
Figure 1. Monthly and Historical Chlorophyll-a Results



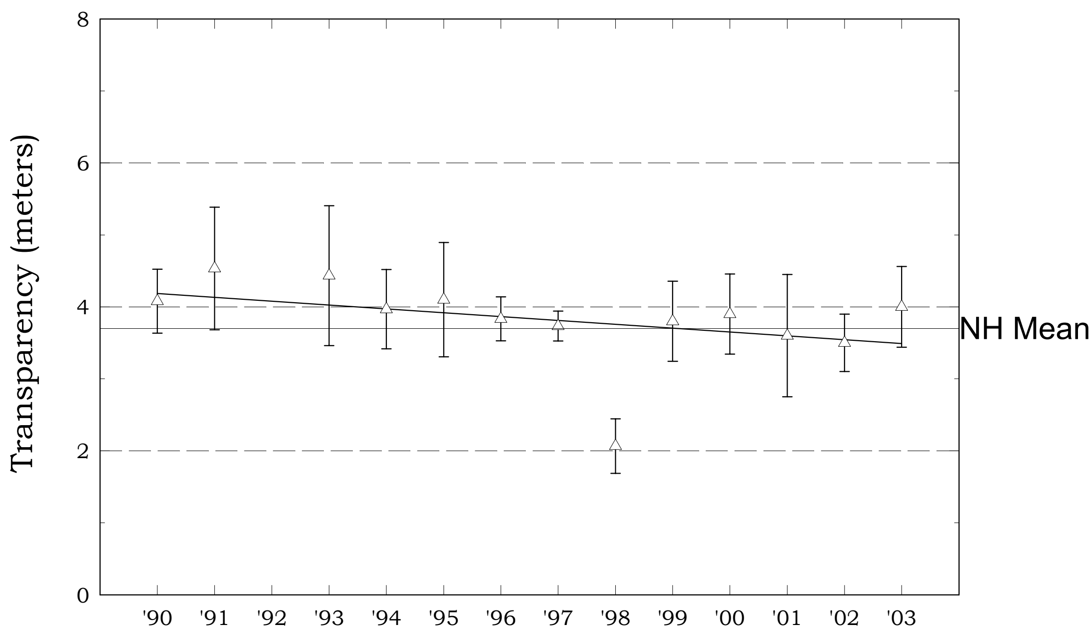


Beaver Lake, Derry

Figure 2. Monthly and Historical Transparency Results



2003 Transparency Results



Historical Transparency Results

Beaver Lake, Derry

Figure 3. Monthly and Historical Total Phosphorus Data.